What is claimed is:

CLAIMS

1. In a flow controller including a flow sensor coupled to a fluid flow path having an inlet side and an outlet side, the flow sensor being adapted to provide a sensor output signal indicative of a sensed fluid flow through the flow path, a method comprising acts of:

measuring at least one pressure of the flow path; and

adjusting the sensor output signal based on the act of measuring the at least one pressure.

2. The method of claim 1, further comprising an act of forming at least one pressure signal based on the at least one pressure.

3. The method of claim 2, further comprising an act of filtering the at least one pressure signal to provide a false flow signal that emulates a response of the flow sensor due to pressure changes in the flow path.

4. The method of claim 3, wherein the act of adjusting the sensor output includes an act of subtracting the false flow signal from the sensor output signal.

5. A method of modifying a sensor output signal from a flow sensor, the method comprising acts of:

constructing a false flow signal corresponding to a response of the flow sensor due to changes in pressure based on at least one pressure measurement of the flow path; and

subtracting the false flow signal from the sensor output signal.

6. The method of claim 5, further comprising an act of providing a pressure signal indicative of the at least one pressure measurement.

7. The method of claim 6, wherein the act of constructing a false flow signal includes an act of delaying the pressure signal such that it is substantially aligned in time with the sensor output signal.

8. The method of claim 6, wherein the act of constructing the false flow signal includes an act of differentiating the pressure signal.

9. The method of claim 6, wherein the act of constructing the false flow signal includes an act of filtering the pressure signal with at least one filter, the at least one filter having a transfer function that emulates a response of the flow sensor to the pressure change in the flow path.

10. The method of claim 9, wherein the at least one filter includes a plurality of 2^{nd}-order filters connected in series, and an output from each of the plurality of 2^{nd}-order filters are scaled and summed to provide the false flow signal.

11. A method of removing false flow information from a sensor output signal provided by a flow sensor coupled to a flow path, the false flow information resulting from the flow sensor responding to flow changes caused by pressure transients, the method comprising acts of:

measuring at least one pressure in the flow path;

providing at least one pressure signal indicative of the at least one pressure measurement;

constructing a false flow signal from the at least one pressure signal; and

subtracting the false flow signal from the sensor output signal to provide a flow signal indicative of the fluid flow in the fluid path.

12. A method of dead volume compensation, the method comprising acts of:

predicting a response of a sensor to a fluid filling a dead volume due to pressure changes in a fluid flow path; and

modifying a sensor output signal provided by the sensor based on the predicted response to essentially remove false flow information from the sensor output signal.

13. A method of determining a flow rate of a fluid flowing in a conduit, comprising acts of:

a) sensing a flow rate of the fluid flowing in the conduit;

b) measuring a change in pressure of the fluid flowing in the conduit;

c) determining an effect of the change in pressure on the flow rate of the fluid sensed by act (a); and

d) modifying the sensed flow rate of the fluid based upon the effect of the change in pressure to determine the flow rate of the fluid flowing in the conduit.

14. A flow meter comprising:

a flow sensor adapted to measure fluid flow in a flow path, the flow sensor providing a sensor output signal in response to sensed fluid flow in the flow path;

at least one pressure transducer to measure at least one pressure in the flow path, the at least one pressure transducer providing at least one pressure signal related to the respective at least one measured pressure;

a compensation filter to receive the at least one pressure signal, the compensation filter adapted to construct a false flow signal approximating a response of the flow sensor to pressure transients in the flow path; and

a subtractor to receive the sensor output signal and the false flow signal and to provide a flow signal related to the difference between the sensor output signal and the false flow signal.

15. The flow meter of claim 14, wherein the compensation filter includes a delay block that delays the at least one pressure signal to be substantially aligned in time with the response of the flow sensor to pressure transients, and wherein the delay block provides at least one delayed pressure signal.

16. The flow meter of claim 15, wherein the compensation filter includes a differentiator to receive the delayed pressure signal, the differentiator being adapted to determine a derivative of the delayed pressure signal to provide a derivative signal.

17. A compensation filter for generating a false flow signal from a pressure signal, the compensation filter comprising:

a differentiator receiving a pressure signal indicative of a pressure in a fluid path, the differentiator being adapted to determine a derivative of the pressure signal to provide a derivative signal; and

at least one filter having a transfer function adapted to transform the derivative signal into a false flow signal indicative of false flow information generated by the flow sensor in response to pressure transients.

18. A method of compensating for fluid pressure induced changes in the position of the controlled portion of a valve, the method comprising acts of:

measuring at least one pressure in a valve environment;

providing at least one pressure signal indicative of the at least one pressure measurement, respectively;

calculating a displacement of the controlled portion of the valve based on the at least one pressure signal; and

generating a compensation drive level to move the controlled portion of the valve an amount having an opposite sign of and substantially equal in magnitude to the calculated displacement.

19. A method of preventing the movement of the controlled portion of the a valve due to pressure transients, the method comprising acts of:

predicting a displacement a pressure transient will force the controlled portion of a valve to move based on at least one pressure measurement of a valve environment; and

moving the controlled portion of the valve to counter-act the predicted displacement.

20. An apparatus coupled to a flow path, the apparatus comprising:

a pressure measurement device to measure at least one pressure in a flow path environment and to provide at least one pressure signal indicative of the at least one measured pressure; and

displacement compensation means for receiving the at least one pressure signal and for providing a displacement compensation signal indicating a drive level to compensate for valve displacement of a valve coupled to the flow path caused by pressure changes in the flow path environment.

21. The apparatus of claim 20, wherein the displacement compensation means comprises means for calculating the displacement compensation signal based on a force valve model.

22. The apparatus of claim 21, wherein the force valve model includes a magnetic model of the valve.

23. The apparatus of claim 21, wherein the force valve model has a parameter that indicates a pressure gradient in the valve environment.

24. A flow meter comprising:

a flow sensor adapted to sense fluid flow in a fluid flow path and to provide a sensor output signal indicative of the sensed fluid flow;

at least one pressure transducer adapted to measure at least one pressure in a fluid flow path environment and to provide at least one pressure signal indicative of the at least one measured pressure; and

a compensation filter to receive the at least one pressure signal and to construct a false flow signal related to the at least one pressure signal.

25. The flow meter of claim 24, wherein the false flow signal is constructed to recreate false flow information resulting from the flow sensor response to flow fluctuations caused by pressure transients in the flow path.

26. The flow meter of claim 24, wherein the compensation filter includes a transfer function that emulates a response of the flow sensor to pressure transients in the flow path.

27. The flow meter of claim 24, wherein the false flow signal is subtracted from the sensor output signal to provide a flow signal.

28. In a mass flow controller coupled to a flow path, the mass flow controller having a control loop including a flow meter, a controller, a valve actuator and a valve, a method comprising acts of:

measuring at least one pressure in a fluid path environment;

providing at least one pressure signal indicating at least one pressure measurement;

determining at least one compensation signal based on at least one pressure measurement; and

applying the at least one compensation signal to the control loop of the mass flow controller.

29. The method of claim 28, wherein the act of determining at least one compensation filter includes constructing a false flow signal to recreate false flow information resulting from a response of the flow meter to pressure transients in the flow path environment.

30. The method of claim 29, wherein the act of applying the at least one compensation signal to the control loop includes an act of applying the false flow signal to the control loop to compensate for the flow meters response fluctuations in fluid flow due to pressure transients in the flow path.

31. The method of claim 27, wherein the act of determining the at least one compensation signal includes determining a displacement compensation signal indicative to a drive level to compensate for a valve displacement due to pressure transients.

32. The method of claim 27, wherein the act of determining the at least one compensation signal includes determining a false flow signal and a displacement compensation signal.

33. A mass flow controller having a control loop, the mass flow controller comprising:

a flow meter adapted to sense fluid flow in a fluid flow path and provide a flow signal indicative of the mass flow rate in the flow path;

a controller coupled to the flow meter and adapted to provide a drive signal based at least in part on the flow signal;

a valve actuator adapted to receive the drive signal from the controller;

a valve adapted to be controlled by the valve actuator and coupled to the fluid flow path;

at least one pressure transducer to measure at least one pressure in a mass flow controller environment and to provide at least one pressure signal indicative of measurement of the at least one pressure; and

at least one compensation means to receive at least one pressure signal and to provide at least one compensation signal to the control loop to compensate for effects of a pressure changes in the mass flow controller environment, wherein the control loop of the mass flow controller includes the flow meter, the controller, the valve actuator, and the valve.

34. The mass flow controller of claim 33, wherein the at least one transducer measures an inlet pressure of the flow path and provides an inlet pressure signal.

35. The mass flow controller of claim 34, wherein the at least one compensation means includes a compensation filter to receive the inlet pressure signal and to construct a false flow signal from the inlet pressure signal.

36. The mass flow controller of claim 35, wherein the flow meter includes a flow sensor adapted to sense fluid flow in the flow path and adapted to provide a sensor output signal indicative of the sensed fluid flow.

37. The mass flow controller of claim 36, wherein the compensation filter has a transfer function that emulates the response of the flow sensor to fluid flow resulting from changes in inlet pressure.

38. The mass flow controller of claim 36, wherein the false flow signal is constructed to recreate a false flow information component of the sensor output signal resulting from changes in inlet pressure.

39. The mass flow controller of claim 36, wherein the flow signal is determined by subtracting the false flow signal from the sensor output signal.

40. The mass flow controller of claim 33, wherein the compensation means includes displacement compensation means that receives the inlet pressure signal and provides a displacement compensation signal indicative of a drive level to maintain a controlled portion of the valve substantially motionless in a pressure environment of the valve.

41. The mass flow controller of claim 40, wherein the displacement compensation signal is added to the drive signal to compensate for valve displacement resulting from pressure gradients in the pressure environment of the valve.

42. The mass flow controller of claim 40, wherein the displacement compensation signal is based in part on a force model of the valve.

43. The mass flow controller of claim 42, wherein the force model of the valve includes a magnetic model of the valve.

44. The mass flow controller of claim 42, wherein the force model of the valve includes a parameter for at least one pressure drop across the valve.

45. The mass flow controller of claim 33, wherein the compensation means includes a compensation filter receiving at least one pressure signal and providing a false flow signal constructed to recreate false flow information resulting from the flow meter responding to pressure transients and displacement compensation means to receive at least one pressure signal and to provide a displacement compensation signal indicative of a drive level to compensate for valve displacement caused by a pressure change.

46. A method of configuring a mass flow controller for operation with process operating conditions that differ at least in part from test operating conditions used during production of the mass flow controller, the method comprising acts of:

establishing a response of the mass flow controller with the test operating conditions; and

modifying at least one control parameter of the mass flow controller based on the process operating conditions such that the response of the mass flow controller operating with the process operating conditions does not substantially change.

47. The method of claim 46, wherein the act of modifying the at least one control parameter includes an act of determining a plurality of process gain terms associated with a plurality of components of the mass flow controller based on the process operating conditions, the plurality of components forming a control loop of the mass flow controller.

48. The method of claim 47, wherein the act of determining the plurality of process gain terms includes an act of determining a process reciprocal gain term formed by taking a reciprocal of a product of the plurality of process gain terms, the process reciprocal gain term being a function of at least one variable operating condition.

49. The method of claim 48, wherein the at least one variable operating condition includes at least one pressure in the mass flow controller environment.

50. The method of claim 49, wherein the at least one variable operating condition includes an inlet pressure.

51. The method of claim 49, wherein the at least one variable operating condition includes a set point.

52. A computer readable medium encoded with a program for execution on a processor, the program, when executed on the processor performing a method of configuring a mass flow controller for operation with a set of process operating conditions that differ at least in part from a set of test operating conditions used to establish a response of the mass flow controller during production, the method comprising acts of:

receiving as an input at least one of process fluid species information and process operating conditions; and

modifying at least one control parameter of the mass flow controller based on the input such that the response of the mass flow controller does not substantially change when operated with the process operating conditions.

53. The computer readable medium of claim 52, wherein that act of modifying the at least one control parameter includes an act of determining a plurality of process gain terms associated with a plurality of components of the mass flow controller operating with the process operating conditions, the plurality of components forming a control loop of the mass flow controller.

54. The computer readable medium of claim 53, wherein the act of determining the plurality of gain terms includes an act of determining a process reciprocal gain term formed by taking a reciprocal of a product of the plurality of gain terms, the process reciprocal gain term being a function of at least one variable operating condition.

55. The computer readable medium of claim 54, wherein the at least one variable operating condition includes at least one pressure in the mass flow controller environment.

56. The computer readable medium of claim 55, wherein the at least one variable operating condition includes an inlet pressure.

57. The computer readable medium of claim 55, wherein the at least one variable operating condition includes a set point.

58. A mass flow controller having a control loop, the mass flow controller comprising:

a flow meter adapted to sense fluid flow in a fluid flow path and provide a flow signal indicative of the mass flow rate in the flow path;

a controller coupled to the flow meter and adapted to provide a drive signal based at least in part on the flow signal;

a valve actuator adapted to receive the drive signal from the controller;

a valve adapted to be controlled by the valve actuator and coupled to the fluid flow path;

wherein the control loop of the mass flow controller includes the flow meter, the controller, the valve actuator, and the valve; and

wherein the control loop is adapted to have a substantially constant control loop gain term with respect to at least one variable operating condition during operation.

59. The mass flow controller of claim 58, wherein the at least one variable operating condition includes at least one pressure in the mass flow controller environment.

60. The mass flow controller of claim 59, wherein the at least one variable operating condition includes an inlet pressure.

61. The mass flow controller of claim 59, wherein the at least one variable operating condition includes a set point.

62. A compensation filter for generating a false flow signal from a pressure signal, the compensation filter comprising:

a plurality of filters, at least two of which are connected in series, and wherein a respective output of each of the at least two filters are scaled and summed.

63. The compensation filter according to claim 62, further comprising a differentiator that is adapted to differentiate the pressure signal, and which provides a differentiated signal to the plurality of filters.

64. The compensation filter according to claim 62, further comprising a delay that delays the pressure signal, and which provides a delayed pressure signal to the plurality of filters.